Ratna Sagar

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Education, Our Mission

As per the latest ICSE syllabus 2022

Ratna Sagar
Education, Our Mission!

Revised and Updated

LIVING SCIENCE BIOLOGY

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10

EDUCATION, OUR MISSION

ICSE
Living Science
Biology

Class 10

Chapter 11 Sense Organs

LEARNING OBJECTIVES

The eye and the sense of sight

- ❖ Structure of the eyeball
- ❖ Lens
- ❖ Working of the eye

Common defects of the eye and their correction

- ❖ Short-sightedness or Myopia
- ❖ Long-sightedness or Hyperopia
- ❖ Astigmatism
- ❖ Presbyopia
- ❖ Night-blindness
- ❖ Colour blindness
- ❖ Cataract
- ❖ Squint

The Ear – senses of hearing and balance

- ❖ Mechanism of hearing and balance

Some key terms

Stimulus: A physical event that affects an organism and activates its receptors to bring about a change in its activity.

Receptors: Sensory cells in tissues that receive stimulus from the environment.

1. **Photoreceptors:** respond to light
2. **Chemoreceptors:** respond to chemicals
3. **Mechanoreceptors:** respond to touch
4. **Thermoreceptors:** respond to change in temperature
5. **Phonoreceptors:** respond to sound/ hearing
6. **Exteroceptors:** specialized to detect sensory information from the external environment.

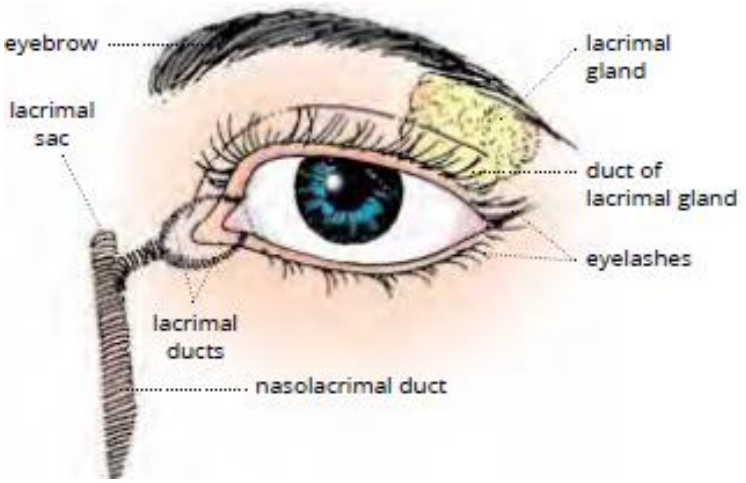
The eye and the sense of sight

Each eye is in the form of a ball called **eyeball** which measures about 2.5 cm (1 inch) in diameter. Each eyeball can be rotated with the help of six distinct sets of muscles.

Accessory structures of the eye

Eyebrows, eyelids, eyelashes and the tear glands (the lacrimal apparatus) are the accessory structures of the eye.

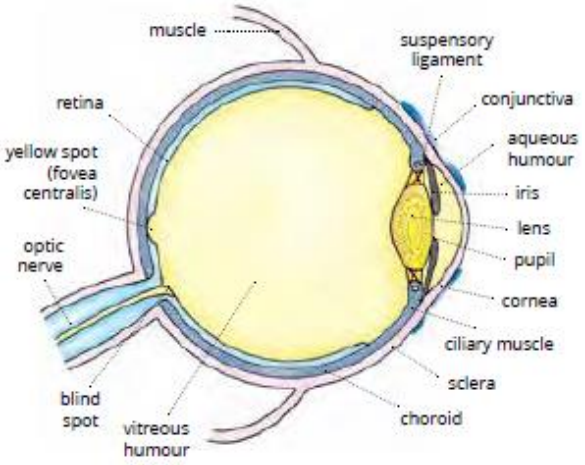
The **eyebrows** protect the eyeball from foreign objects, perspiration and direct rays of sunlight.



Eyelids are folds of skin and muscles. The upper and lower eyelids protect the eyes from excessive light and foreign particles. At the base of hair follicles of eyelashes are found **sebaceous glands**. These glands secrete a lubricating fluid into the hair follicles called **sebum**. **Tear glands** or **lacrimal glands** are a group of glands that manufacture and pour tears. Each lacrimal gland gives rise to 6 to 12 excretory **lacrimal ducts** which empty their secretion. **Tear** or **lacrimal secretion** is a watery fluid containing salts, some mucus and bacteriocidal enzyme called **lysozyme**.)

Structure of the eyeball

The eyeball is a spherical structure measuring about 2.5 cm in diameter. Structurally, eyeball is composed of three layers – the fibrous tunic (anterior cornea + posterior sclera), the vascular tunic also known as uvea (middle layer of the eyeball) (choroid + ciliary body + iris) and the inner retina.



1. Sclerotic layer or sclera

The sclerotic layer or sclera is the outer tough coat of the eyeball made up of mainly collagen fibres. It can be divided into two regions – the posterior region called sclera, and the anterior region called cornea. The **sclera** is a white coat of fibrous tissue visible through conjunctiva that covers all the eyeball except the cornea. It is also known as the **white of the eye.** The sclera gives shape to the eyeball and also protects its inner parts.

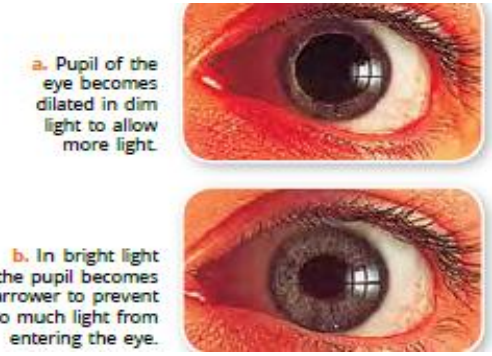
2. Uvea

The **choroid layer is the middle layer of the eyeball** and is composed of three parts – choroid, ciliary body and iris. The **choroid** is a thin, dark brown membrane that lines most of the inner surface of the sclera. The choroid expands to form ciliary body. It consists of circular muscles.

The smooth muscles of ciliary body help in changing the shape of the lens. The **iris** is a coloured part of choroid around the pupil. It is a coloured part seen through the cornea. There is a hole (round window) in the centre of the iris, known as the **pupil**. **The light enters the eyeball through the pupil**. The iris contains **radial** and **circular muscles**.

The contraction of these muscles constricts the pupil which regulates the amount of light entering the eyeball through iris.

- **In case of bright light**, the circular eye muscles contract and the size of the pupil is decreased (constriction).
- **In case of dim light**, the radial muscles contract and the size of the pupil is increased (dilation).



Effect of light intensity on the size of pupil

3. Retina – part of the eye where rod and cone cells are located

The **retina** is the third and the inner layer of the eye. It is located only in the posterior part of the eye. It is the light-sensitive layer. It contains light-sensitive cells called **rods** and **cones**. The **rod** cells are sensitive to dim light. They do not respond to colour. **Rods contain pigment rhodopsin** or visual purple. The rod cells are distributed throughout the retina.

The **cone** cells are sensitive to bright light. The cones are responsible for colour vision. **Cones contain pigment iodopsin**. Cone cells are mostly confined to the yellow spot or fovea centralis or macula.

Lens

The main body of the eye is divided into two parts by a **biconvex lens** which is a transparent crystalline body. The lens lies just behind the pupil and iris. It is flatter at the front than at the back and is soft and slightly yellow in colour. It contains transparent **lens fibres** and an elastic **lens capsule** made of glycoprotein. There is no blood vessel in the lens.

The eyeball is divided into two chambers:

1. The anterior chamber (between the lens and cornea) is filled with a fluid called the **aqueous humour**. It is a thin and watery fluid. It keeps the lens moist and protects it from the physical shock.

2. The posterior chamber is called the **vitreous chamber**. It is a large cavity of the eyeball. It lies between the lens and the retina. It contains a jelly-like substance called the **vitreous humour**.The vitreous humour maintains the shape of the eyeball by preventing the eyeball from collapsing and supports the retina.

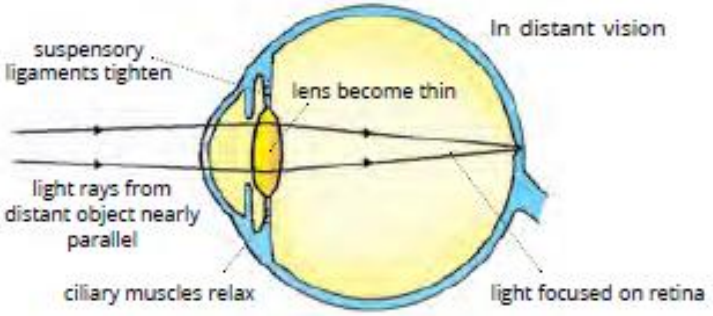
How do we see – Working of the eye

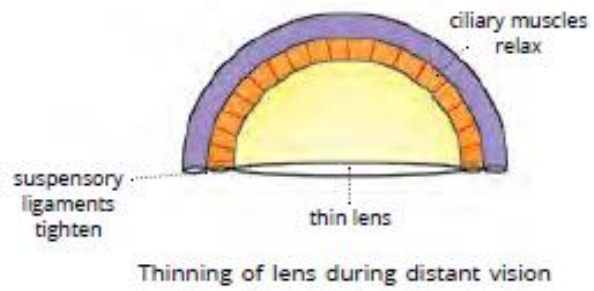
1. Light rays enter the eye

The light rays enter the eye through cornea and then passes through the pupil, aqueous humour, the lens and the vitreous humour (all transparent structures), before reaching the retina.

2. Image formation on the retina

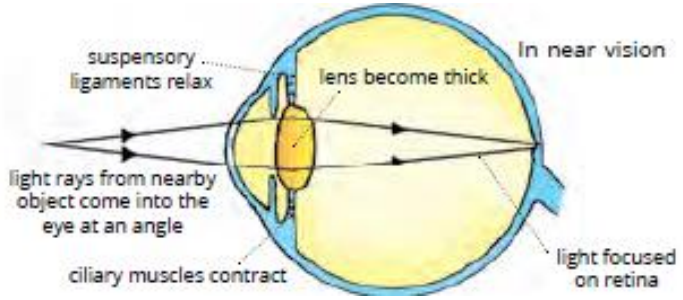
The formation of an image on the retina requires four steps – **a.** refraction of light rays, **b.** accommodation of the lens, **c.** constriction of the pupil, and **d.** convergence of the rays.

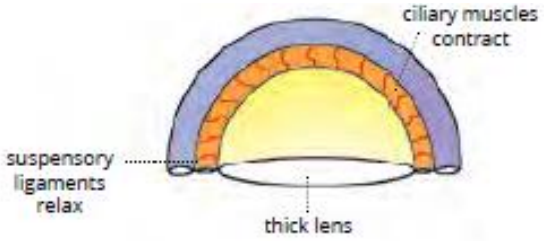




Thinning of lens during distant vision

Image formation on the retina in distant vision.





Thickening of lens during near vision

Image formation on the retina in near vision

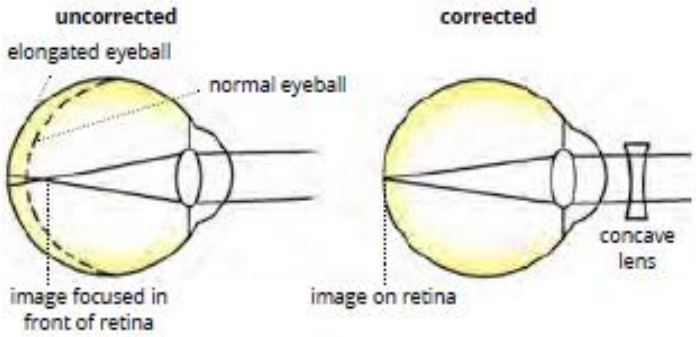
3. Photoreception by brain

The image formed at retina stimulates photoreceptors. The light energy of the image formed at retina produces chemical changes in the rods and cones. This generates nerve impulses which travel through the optic nerve from retina to the visual area of the brain. At cerebrum , the sensation of sight is interpreted.

Common defects of the eye and their correction

Short-sightedness or Myopia

In this condition, **light is focused in front of the retina**, and a blurred image is formed for distant objects. In myopia, the near objects are seen clearly while the distant objects appear blurred. This happens because either the eyeball is elongated or the lens has become too thickened or curved. **Myopia can be corrected by using a concave (diverging) lens.**



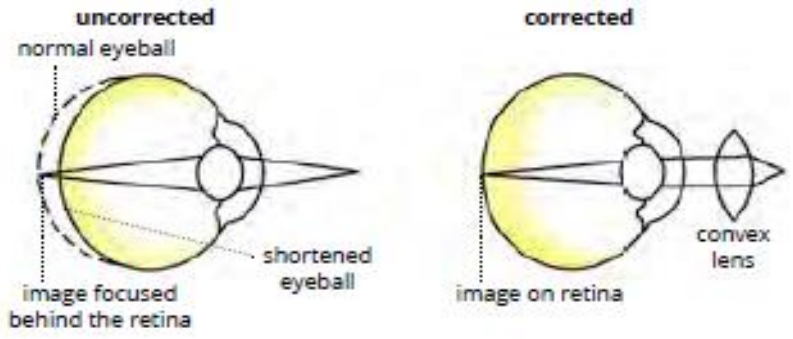
Short-sightedness – an image formed in front of the retina (myopia)

Long-sightedness or Hypermetropia

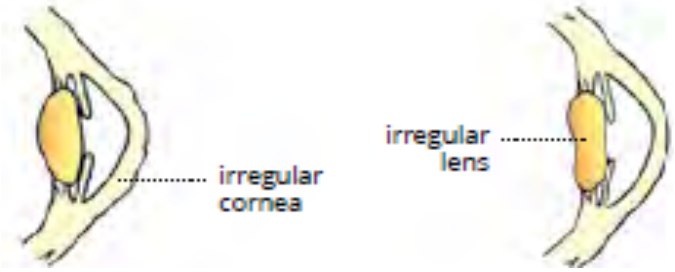
In this condition, **the light is focused behind the retina** (the image is formed behind the retina).

As a result, the distant objects are seen clearly, while the near objects appear blurred. Long-sightedness results due to shortening of the eyeball or the lens has become too thin.

Hypermetropia can be corrected by using a convex (converging) lens.



Long-sightedness – an image formed behind the retina (hypermetropia)



Astigmatism can result from an irregular cornea or an irregular lens.

Astigmatism

This is a more complicated defect in vision. In this, the surface of cornea becomes irregular and therefore some of the light rays are focused while others are not. As a result, some parts of the object appear blurred while other parts appear clear. **Astigmatism can be corrected by using a cylindrical lens that bends light rays in one direction only.**

Presbyopia

In this condition, the lens loses its flexibility causing long-sightness (the near objects cannot be seen clearly). This defect normally occurs in the older people. **Presbyopia can be corrected by using convex lens.**

Night-blindness

In this condition, there is difficulty in seeing in the dim light (hence the name night blindness). This is **because of non-production of rhodopsin pigment** in the rod cells, which function in dim light. In the absence of rhodopsin these cells cannot function. Thus, there is lack of normal night vision. It is most often caused due to deficiency of vitamin A.

Night blindness can be cured by having Vitamin A rich diet.

Colour blindness

In this condition, a person is unable to discriminate between red and green colours. This is a genetic defect about which you have already studied in the chapter on heredity and genetics (X-linked inheritance).

Colour blindness cannot be treated during the lifetime of an individual.

Cataract

In this condition, the lens of the eye becomes opaque and as a result the vision is cut down. **Cataract can be treated by surgical removal of lens and using convex lenses in the spectacles which compensate for the removed lens**. Nowadays, a small plastic lens is implanted behind the iris to correct the defect.

Squint

In this condition, either the two eyes somewhat converge (known as cross-eye) or diverge (known as wide-eye). In both these conditions, a person may have double vision. Squint in the eyes can be treated by surgery or by suitable exercises.

The Ear – senses of hearing and balance

Humans have two ears, one on each side of the head. Human ears are organs for senses of hearing and balance. The ear is a miniature receiver, amplifier and signal processing system.

Structure of ear

The human ear is divided into three parts:

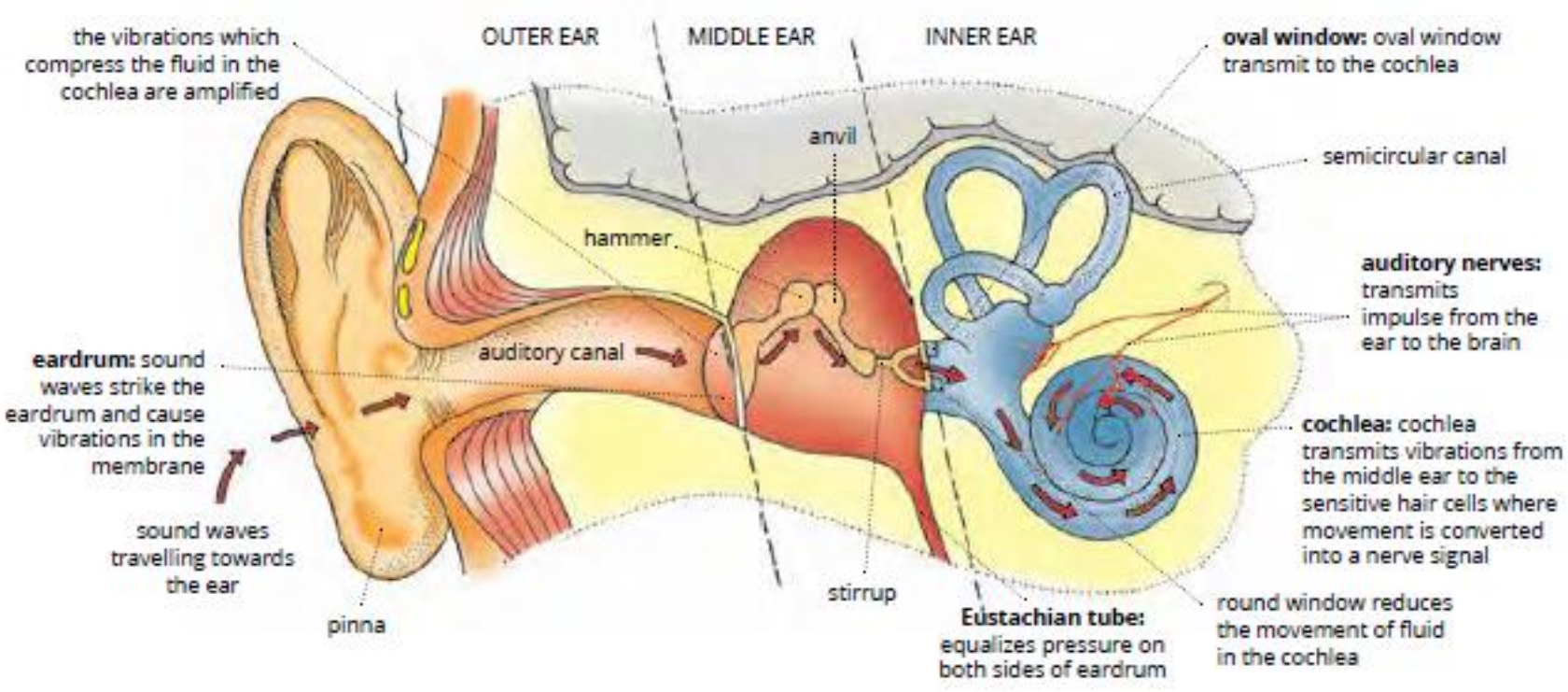
1. External or outer ear

It consists of external visible part of ear called **pinna** (or auricle) and internal part, **auditory canal**. The auditory canal is the passage leading to the eardrum.

2. Middle ear

The middle ear is a small air-filled cavity. It is separated from the external ear by the **eardrum** (**tympanic membrane**) and from the internal ear by a thin bony partition which contains two small openings namely,
oval window and **round window**.

The middle ear contains three tiny bones called **ear ossicles**. These bones are named as **malleus** (or hammer), **incus** (or anvil) and **stapes** (or stirrup). The anterior wall of the middle ear contains an opening that leads directly into the auditory tube (also known as Eustachian tube). This connects middle ear with the throat thus any throat infection may lead to the ear through the Eustachian tube. The Eustachian tube also helps in equalizing air pressure on both sides of the eardrum helping it for free vibration.

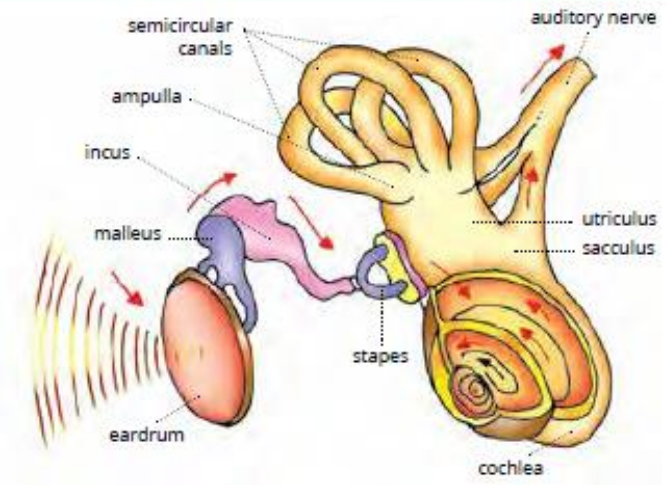


Various parts of human ear and mechanism of hearing

3. Internal ear

The internal or inner ear is also called **membranous labyrinth**. It has two main parts – cochlea and semicircular canals.

(a) Cochlea: It is a hollow, spiral-shaped (coiled), chamber. It resembles a snail's shell.



It consists of a bony spiral canal that makes about 2¾ turns around a central bony core. Its inner spiral cavity contains three separate channels or canals that run parallel. The median (cochlear) canal is filled with **endolymph** and the outer two canals are filled with a fluid called **perilymph**.

The middle canal contains a **spiral organ** called the **organ of Corti**. **The organ of Corti is the organ of hearing.** It contains a series of nerve cells and hair cells which join the auditory nerve and help in hearing.

(b) Semicircular canals: The inner ear also contains three **semicircular canals**. These canals are arranged at right angles to each other in three different planes and is filled with endolymph. One end of each canal is swollen to form an ampulla. The **ampulla** contains sensory cells which help in balance of the body while moving. The nerve fibres arise from these cells and join the **auditory nerve**.

The external ear, middle ear and cochlea help in hearing. The sacculus, utriculus and the semicircular canals help in the sense of balance.

Mechanism of hearing and balance Hearing

Pinna collects and amplifies sound waves which then pass along the auditory canal to the eardrum.

❖ Sound waves strike the eardrum (tympanum) and cause vibrations in its thin stretched membrane. The Eustachian tube equalizes air pressure on either side of eardrum which allows a free vibration.

❖ The vibrations reach ear ossicles in the middle ear. Ear ossicles transmit vibrations from the eardrum to the denser fluid in the inner ear.

❖ The lever-like action of malleus and incus magnifies the vibrations of the stapes.

❖ The vibrating stapes transmits vibrations to the membrane of the oval window.

❖ Vibrations from oval window get transmitted to cochlea. This leads to vibration in the fluid of cochlear canals.

❖ Vibration of fluid in cochlear canals triggers movement of sensory hair cells of organ of Corti in cochlea.

❖Movement of sensory hair cells is converted to a nerve impulse.

❖ Nerve signal or impulse is transmitted to brain via auditory nerve and this results in hearing.

Balancing

The following parts of ear are involved with balance.

1. Static balance with respect to centre of gravity: Sensory cells in vestibule

2. Dynamic balance (while the body is in motion): Sensory cells in semi-circular canals Movement of fluid inside semicircular canals triggers sensory hair cells of ampulla. This sensation passes to nerve cells and then to brain. The three canals are at right angles to each other so that the brain can detect even slightest tilting of the body in any direction.

SUMMARY...

❖ Receptors are the special cells that receive stimulus from the environment. Some common receptors are photoreceptors, chemoreceptors, thermoreceptors and mechanoreceptors.

❖ Receptors are contained in sense organs. There are five major sense organs in humans – eyes (vision), ears (sound), nose (smell), tongue (taste) and skin (pressure and touch). Each of these sense organs is directly connected to the brain.

❖ Each eye is in the form of a ball called eyeball that can be rotated by six distinct sets of muscles.

❖ Eyebrows, eyelids, eyelashes and tear glands are the accessory structures of the eye.

❖ Lacrimal glands are a group of glands that manufacture tears. Tears serve as a lubricant and also kill the germs that enter the eye.

❖ Conjunctiva is a membrane that covers the entire front part of the eye.

❖ The eyeball has three layers – the sclerotic layer, the choroid and the retina.

❖ The sclerotic layer is the outer tough coat of eyeball that is divided into sclera (white coat of dense fibrous tissue) and cornea (transparent fibrous coat through which the iris can be seen).

❖ The choroid layer is the middle layer of the eyeball and is composed of three parts – choroid, ciliary body and the iris. There is a hole in the centre of iris called the pupil.

❖ The retina is the third and inner coat of the eye. It contains light-sensitive cells called rods (sensitive to dim light) and cones (sensitive to bright light).

❖The lens focuses light rays from outside and real, inverted image is formed at yellow spot.

❖ The yellow spot is the area of best vision, while blind spot is the area of no vision.

❖ In myopia, the image is formed in front of retina. It can be corrected by using concave lens.

❖ Ear is concerned with two functions – hearing and body balance.

❖ While listening, the sound waves are collected by the pinna and pass through auditory canal and set eardrum into vibration. It sets malleus, incus and stapes (ear ossicles) into motion. From stapes, vibrations move to oval window, then to cochlear canal and sensory hairs in cochlea. From here the nerve impulse reaches the brain through the auditory nerve.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